

**FMC Corporation
Peroxygen Chemicals Division
Bayport Plant**

Pasadena, Texas



**RCRA Facility Investigation
Report**

Volume I

ENSR Consulting and Engineering

March 1991

Document Number 2810-018

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CONTENTS

EXECUTIVE SUMMARY	E-1
1.0 INTRODUCTION	1-1
1.1 Background	1-1
1.2 RFI Program Objectives	1-1
2.0 FACILITY INFORMATION AND HISTORY	2-1
2.1 Site Location	2-1
2.2 RFI Unit Specifications and History	2-1
2.3 Spill History	2-1
2.4 Changes in Operational Status of RFI Units	2-7
3.0 RFI FIELD AND ANALYTICAL PROGRAM	3-1
3.1 Phase I Soil Investigation	3-2
3.2 Phase I Waste Characterization	3-5
4.0 LABORATORY ANALYTICAL RESULTS	4-1
4.1 Expired Volatile Organic Soil Samples	4-1
4.2 Appendix IX Metals Samples	4-1
5.0 EVALUATION OF ANALYTICAL DATA	5-1
5.1 Statistical Evaluation of RFI Units 1 and 2 Soil Sample Data	5-1
5.1.1 Statistical Test Method Selection	5-2
5.1.2 Evaluation of Arsenic Data	5-4
5.1.3 Evaluation of Chromium Data	5-8
5.1.4 Evaluation of Lead Data	5-15
5.1.5 Evaluation of pH Data	5-16
5.2 Summary of RFI Units 3 Through 8 Waste Analysis Data	5-22
6.0 SUMMARY OF RFI FINDINGS	6-1
6.1 RFI Units 1 and 2	6-1
6.1.1 Geologic Conditions	6-1
6.1.2 Appendix VIII Release Determination	6-1
6.2 RFI Units 3 Through 8	6-3

CONTENTS
(Cont'd)**APPENDICES**

- A AGENCY CORRESPONDENCE
- B PHASE I FIELD NOTES
- C PHASE I SOIL BORING LITHOLOGIC LOGS
- D AUGUST 7, 1990 LETTER REPORT FOR FEBRUARY 26, 1990 SAMPLING
OF RFI UNITS 3 AND 4
- E STATISTICAL EVALUATION WORK SHEETS
- F PHASE I LABORATORY ANALYTICAL REPORT
 - F.1 NOVEMBER 1990 SAMPLING RESULTS
 - F.2 FEBRUARY 1991 SAMPLING RESULTS

LIST OF TABLES

2-1	RFI Solid Waste Managements Units	2-3
2-2	RFI Solid Waste Management Unit Information Summary	2-5
4-1	Laboratory Analytical Report Summary - Phase I Soil Samples	4-2
4-2	Laboratory Analytical Report Summary - Appendix IX Analytical Results	4-7
5-1	Ranking Data for Non-Parametric ANOVA - Arsenic Concentrations	5-6
5-2	Parametric ANOVA Data - Chromium Concentrations	5-11
5-3	Parametric ANOVA Table - Chromium Data	5-13
5-4	Parametric ANOVA Data - pH Concentrations	5-18
5-5	Parametric ANOVA Table - pH Data	5-20

LIST OF FIGURES

2-1	Site Location Map	2-2
2-2	Production Site Plot Plan	2-4
3-1	RFI Unit Soil Boring Locations	3-3
6-1	Cross Section A-A'	6-2

EXECUTIVE SUMMARY

On November 8, 1989, the U.S. Environmental Protection Agency Region 6 issued a Hazardous Waste Permit to the FMC Corporation Peroxygen Chemicals Division Bayport Plant in Pasadena, Texas. The permit required FMC to perform a RCRA Facility Investigation (RFI) for the following Solid Waste Management Units (SWMUs):

- Contaminated Sewer Lift Station
- Process Sewer Lift Station
- Used Work Solution Tank
- Used Work Solution Tanks 716A and B
- Check Tank T4889C
- H₂O₂ Sewer Pits
- Oily Sewer Pits
- Wastewater Surge Tank T4820

The permit required a subsurface investigation at the Contaminated and Processes Sewer Lift Stations to determine whether Appendix VIII constituents had been released from these units. An Appendix VIII waste characterization was required for the remaining SWMUs.

To meet these requirements, FMC retained ENSR Consulting and Engineering to prepare and implement an RFI Work Plan. This Work Plan was submitted to TWC and EPA in January 1990 and approved in October 1990. The Work Plan was subsequently implemented.

The significant results of the investigation indicate that:

- Various Appendix VIII/40 CFR 264 Appendix IX constituents were detected in each of the SWMUs which were subject to an Appendix VIII waste characterization.
- There is no evidence of release of Appendix VIII constituents having occurred from the Contaminated Sewer Lift Station and the Process Sewer Lift Station.

This report concludes the RCRA facility investigation for the FMC Corporation Peroxygen Chemicals Division Bayport Plant.

1.0 INTRODUCTION

1.1 Background

On August 28, 1989 the Texas Water Commission (TWC) issued a Hazardous Waste Permit to the FMC Corporation Peroxygen Chemicals Division Bayport Plant in Pasadena, Texas. On November 8, 1989, the U.S. Environmental Protection Agency, Region 6 (EPA) issued this same permit, effective November 8, 1989, under the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984 (HSWA), and provided that the permit is a joint TWC and EPA permit. As a requirement of the Permit (Provision VIII), FMC was required to perform a RCRA Facility Investigation (RFI) to determine whether hazardous constituents, listed in 40 CFR 261 Appendix VIII, had been released into the environment from certain Solid Waste Management Units (SWMUs).

In November 1989, FMC Corporation retained ENSR Consulting and Engineering to prepare the RFI Work Plan. The RFI Work Plan was submitted to TWC and EPA in January 1990. On July 27, 1990, Minor Brooks Hibbs of TWC sent a letter to Mr. Roger Threde of FMC, which contained the TWC's comments to the RFI Work Plan. On September 21, 1990 FMC issued a revision to the RFI Work Plan which addressed TWC's comments. On October 8, 1990 TWC approved the RFI Work Plan. Copies of these correspondence are provided in Appendix A.

1.2 RFI Program Objectives

The objectives of the RFI are as follows:

1. To determine whether a significant release of Appendix VIII constituents has occurred from the Contaminated Sewer Lift Station and Process Sewer Lift Station;
2. To determine the extent of the release, should it be determined that a release of Appendix VIII constituents has indeed occurred from the Process Sewer Lift Station and the Contaminated Sewer Lift Station, and;
3. To perform an Appendix VIII/40 CFR 264 Appendix IX waste characterization of the following SWMUs:
 - Used Work Solution Tank
 - Used Work Solution Tanks 716A and B

- Check Tank T4889C
- H₂O₂ Sewer Pits
- Oily Sewer Pits
- Wastewater Surge Tank T4820

The RFI Work Plan proposed a two-phased approach to meet these objectives. Phase I was designed to address Objectives 1 and 3 above; Phase II was designed to address Objective 2.

The results of the Phase I investigation indicated that a release of Appendix VIII constituents had not occurred from the Process and Contamination Sewer Lift Stations. Therefore, Phase II was not required.

This document presents a discussion of the activities and results of the Phase I investigation, and concludes the RCRA Facility Investigation for the FMC Corporation Peroxygen Chemicals Division Bayport Plant.

2.0 FACILITY INFORMATION AND HISTORY

The FMC Corporation Bayport Plant began operation in 1969. Initially the plant produced glycerine, acetic acid, epoxidized soybean oil, and allyl alcohol products. Peracetic acid was produced as an intermediate in the glycerine manufacturing process. In 1979, hydrogen peroxide manufacturing was added to the plant. Due to market conditions, in 1982 the plant ceased production of all products except hydrogen peroxide and allyl alcohol. Currently, only hydrogen peroxide is produced as the allyl alcohol unit was shut down in November 1989.

2.1 Site Location

The FMC Corporation, Peroxygen Chemicals Division, Bayport Plant, is located at 12000 Bay Area Boulevard in Pasadena, Texas, Harris County. Figure 2-1 is a site location map depicting the active portion of the facility. Approximately 80 acres of the facility have been developed for industrial use.

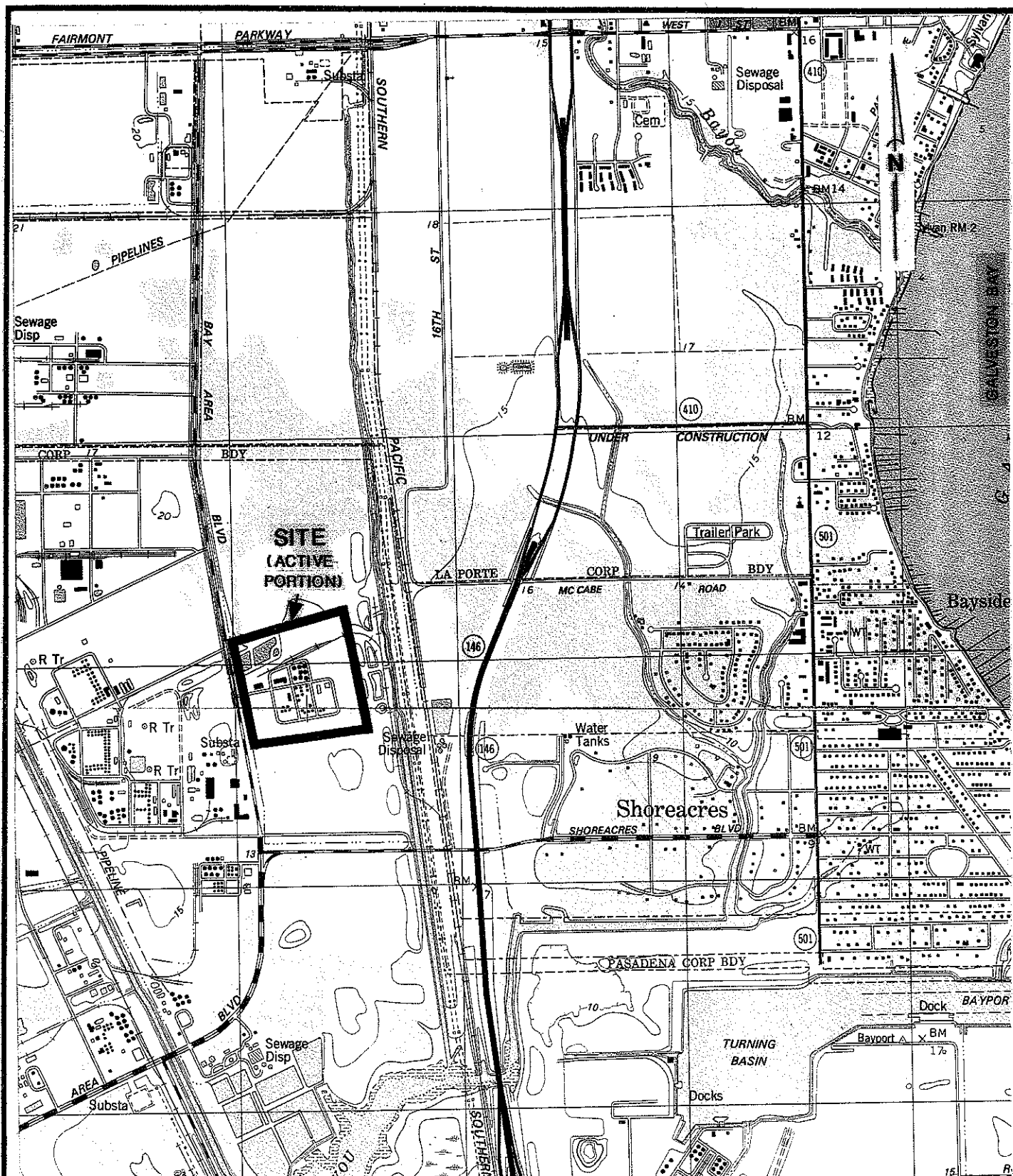
2.2 RFI Unit Specifications and History

Based on the results of the RCRA Facility Assessment (RFA), TWC and EPA identified eight solid waste management units for the RFI. These units are listed on Table 2-1. The locations of these eight units are identified on Figure 2-2.

Information obtained from site records and personnel interviews was reviewed. Data were obtained on potential facility contaminants, unit dimensions and capacities, construction materials, and operational history. Table 2-2 summarizes each RFI unit's specifications, history, and potential contaminants.

2.3 Spill History

Based upon ENSR's review of all available data and on-site visit, no records exist of a spill having occurred from any of the RFI units.



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**FIGURE 2-1
SITE LOCATION MAP
FMC CORPORATION
PEROXYGEN CHEMICAL DIVISION
PASADENA, TEXAS**

Ref.: USGS La Porte, Texas, 1982 & League City, Texas,
1982, Quadrangle Maps

DRAWN BY: CS

DATE: 12-20-89

PROJECT NO.: 2810-014

CHK'D BY:

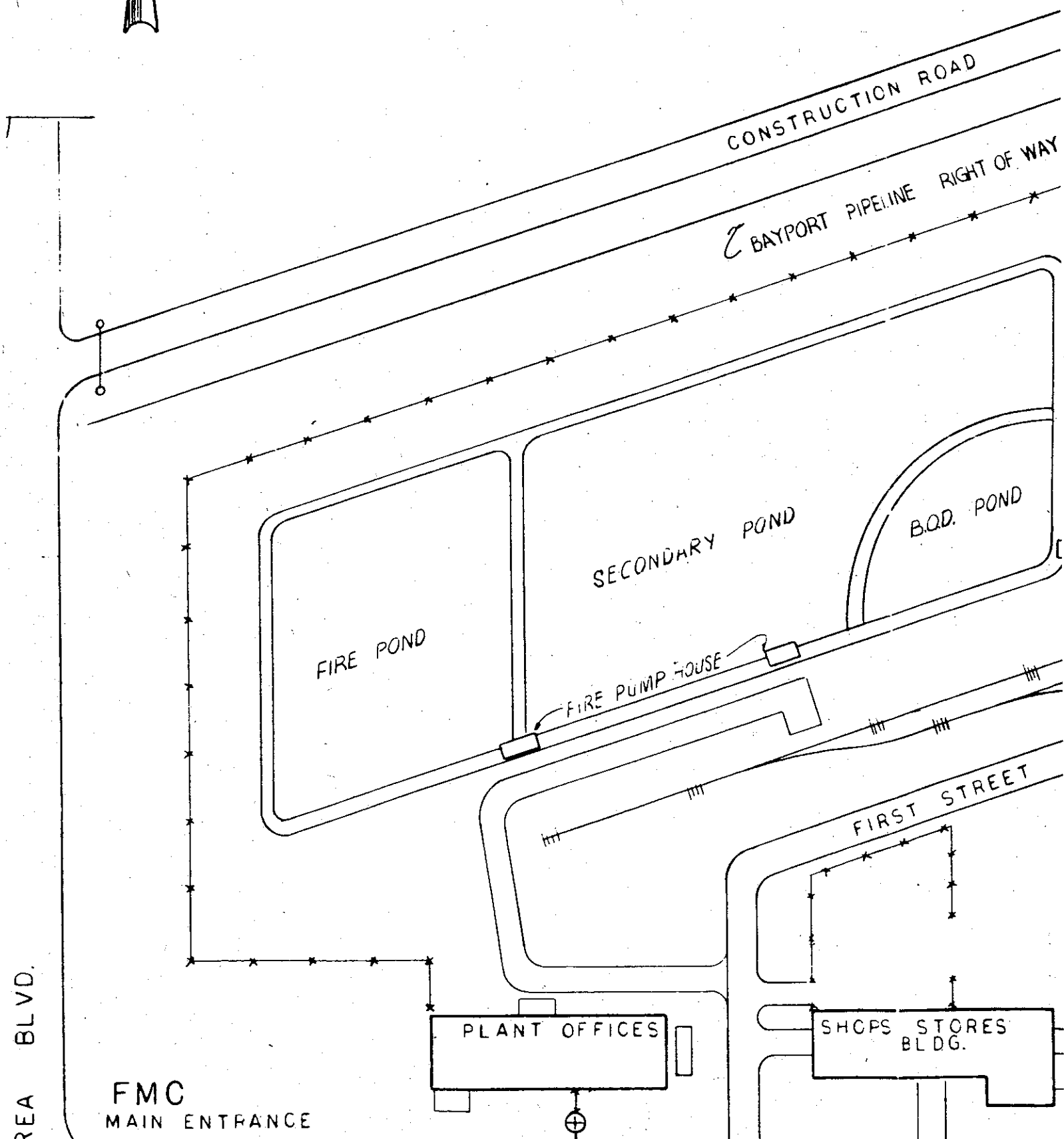
REVISED:

DWG. NO.:

TABLE 2-1

**RFI Solid Waste Managements Units
RCRA Facility Investigation
FMC Corporation
Peroxygen Chemicals Division
Bayport Plant
Pasadena, Texas**

RFI Unit No.	Unit Name	Operational Status
1	Contaminated Sewer Lift Station	Inactive, Process Stormwater Only
2	Process Sewer Lift Station	Inactive
3	Used Work Solution Tank	Inactive
4	Used Work Solution Tanks 716 A & B	Inactive
5	Check Tank T4889 C	Active
6	H ₂ O ₂ Sewer Pits	Active
7	Oily Sewer Pits	Active
8	Wastewater Surge Tank	Active



BAY

PLANT PARKING LOT

SHIFT
PARKING
LOT

MAINTENANCE CONTRACT
PARKING LOT

EXIST. TRUCK
PARKING

SUBCONTRACT
PARKING LOT

B STREET

TRUCK
SCALES

BARREL STORAGE
PAD

MCC

MS-725

INCINERATOR

HOT C
HEATE

BKG-1R

BKG-1

CORRIDOR #50 2

LOADING AREA

LOADING AREA

HYDROGEN
PEROXIDE DISTN.

WAREHOUSE

T-4491

A B

4

8

TANK FARM

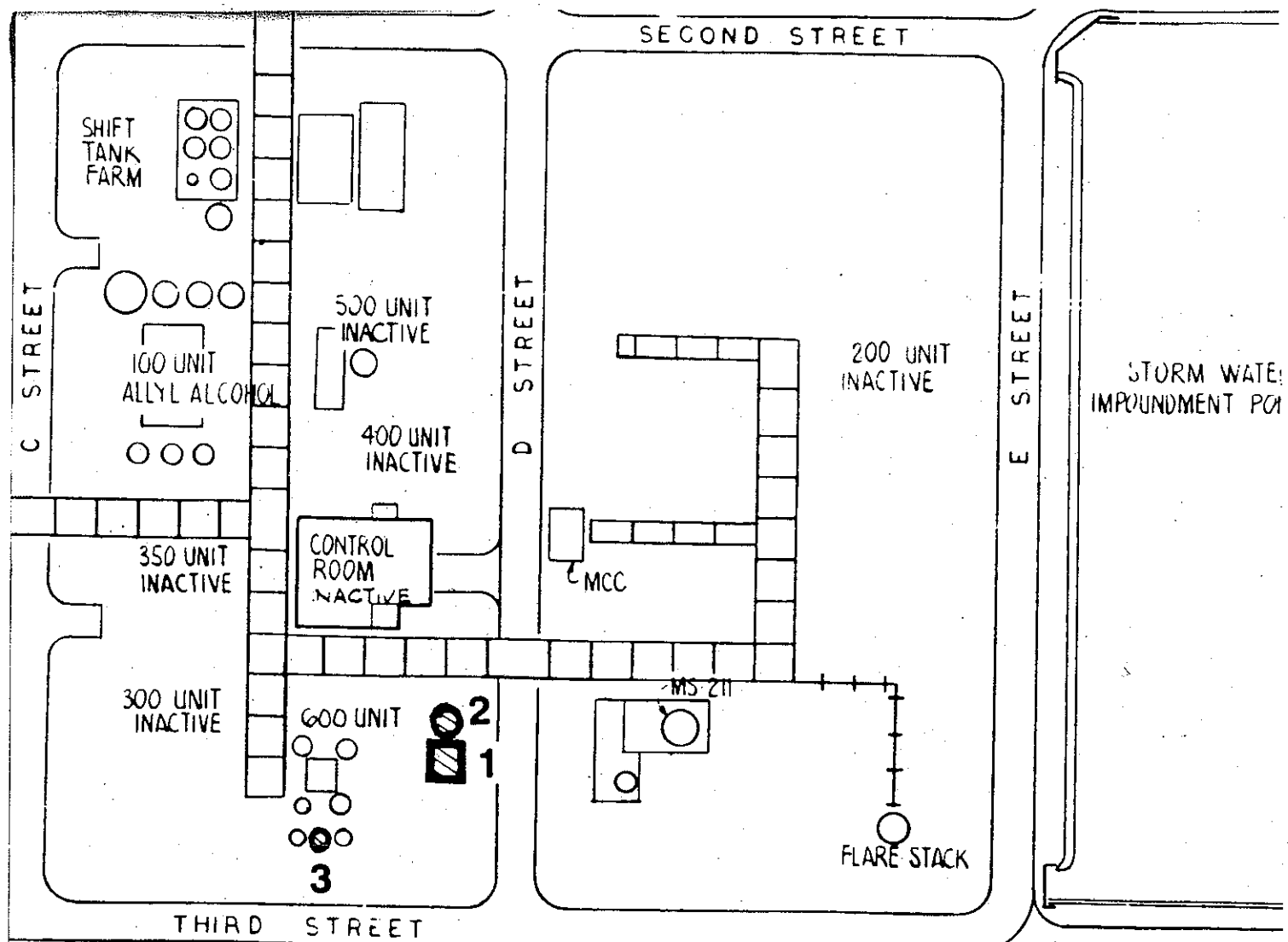
TANK FARM

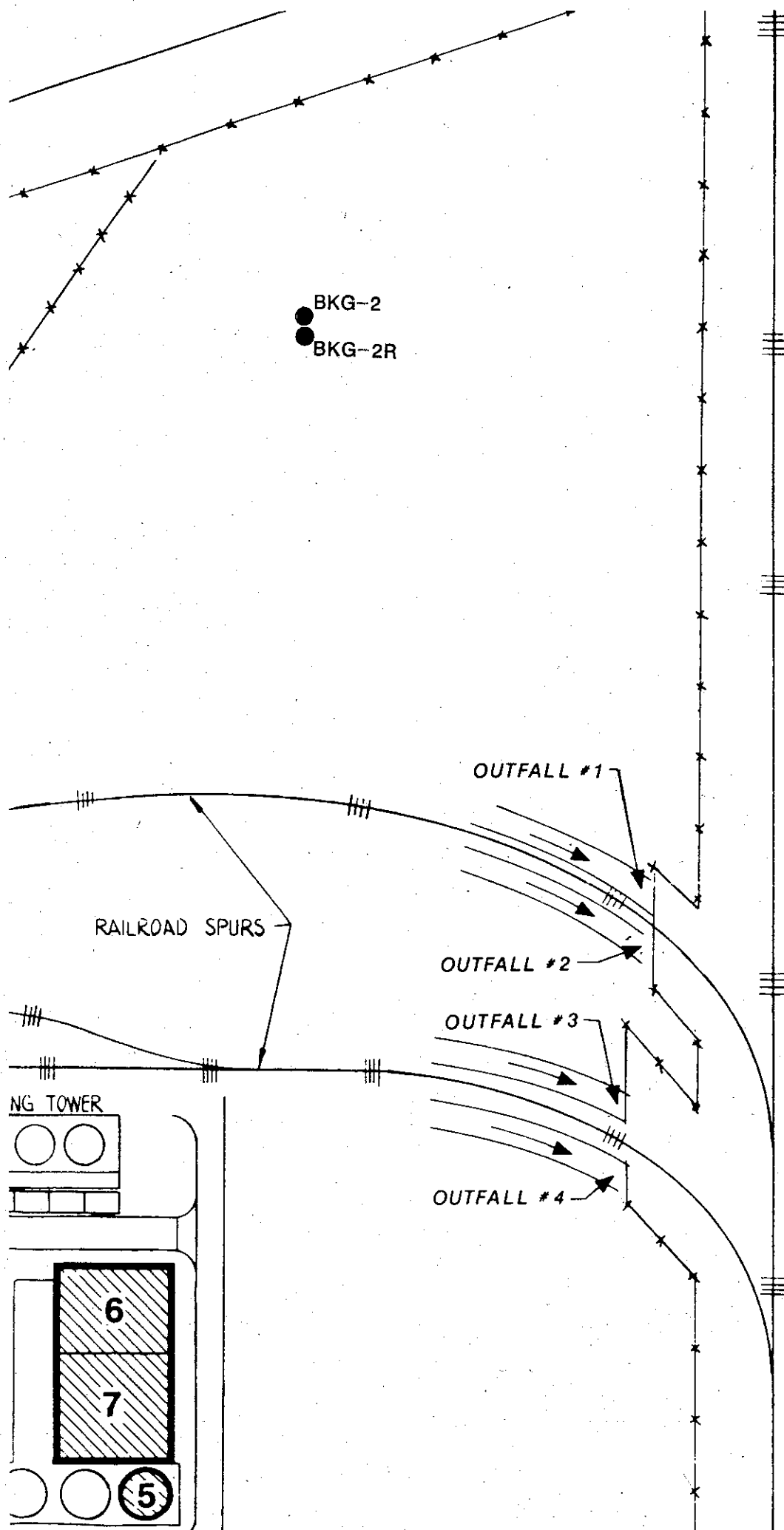
FOURTH STREET

HYDROGEN PEROXIDE
PROCESS AREA

CONTROL
HOUSE

F STREET

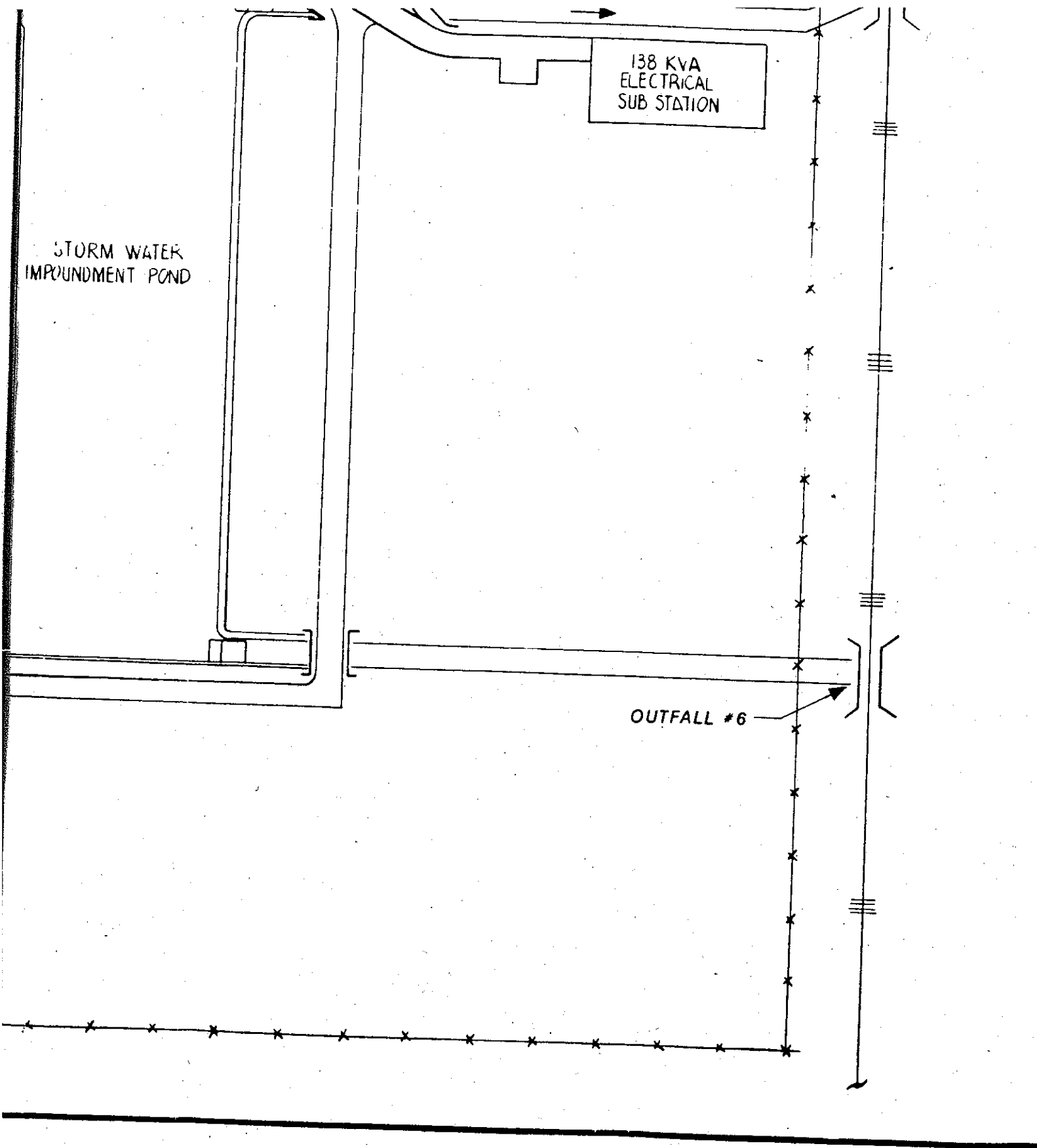




138 KVA
ELECTRICAL
SUB STATION

STORM WATER
IMPOUNDMENT POND

OUTFALL #6



SURVEY INFORMATION
(by Shanks Land Surveyors of Texas)

BORING	NORTH	EAST	ELEVATION FT., MSL
BKG-1	1775.2	458.9	13.3
BKG-1R	1777.6	458.7	
BKG-2	3393.9	1731.2	15.2
BKG-2R	3396.3	1731.0	

EXPLANATION

BKG-1 ● BACKGROUND SOIL BORING LOCATIONS



RFI SOLID WASTE MANAGEMENT UNITS

1. RFI UNIT 1 - CONTAMINATED SEWER LIFT STATION
2. RFI UNIT 2 - PROCESS SEWER LIFT STATION
3. RFI UNIT 3 - USED WORK SOLUTION TANK
4. RFI UNIT 4 - USED WORK SOLUTION TANKS 716 A & B
5. RFI UNIT 5 - CHECK TANK T4889C
6. RFI UNIT 6 - H₂O₂ SEWER PITS
7. RFI UNIT 7 - OILY SEWER PITS
8. RFI UNIT 8 - WASTEWATER SURGE TANK



ENSRTM

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FIGURE 2-2
PRODUCTION SITE PLOT PLAN
FMC CORPORATION
BAYPORT PLANT
PASADENA, TEXAS

DRAWN BY: CS

DATE:

PROJECT NO.: 2810-014

CHK'D BY:

REVISED:

DWG.NO.:

TABLE 2-2

RFI Solid Waste Management Unit Information Summary
RCRA Facility Investigation
FMC Corporation
Peroxygen Chemicals Division
Bayport Plant
Pasadena, Texas

RFI Unit/History	Potential Appendix VIII Constituents	Dimensions/Capacity/Construction
1. Contaminated Sewer Lift Station active since 1968.	Allyl Alcohol Acrolein Phenol Naphthalene	23,000 gallons Below grade reinforced concrete open vault, 16.3 ft. in depth below grade.
2. Process Sewer Lift Station.	Allyl Alcohol Acrolein	1,000 gallons Open top, below grade metal tank which is inside a steel cylinder. 15.3 ft. in depth below grade.
3. Used Work Solution Tank came on-line in 1986 to service Alkane Wash Unit; prior to 1986 used as allyl alcohol feed tank. Currently inactive.	Naphthalene Phenol	3,000 gallons above grade, closed vessel, situated on concrete pedestal.
4. Used Work Solution Tanks 716 A & B - came on-line in 1986; prior to 1986 used for product glycerin storage. Currently inactive.	Naphthalene Phenol	80,000 gallons each, above grade, closed vessels on concrete pedestals.

TABLE 2-2 (Cont'd)

RFI Solid Waste Management Unit Information Summary
RCRA Facility Investigation
FMC Corporation
Peroxygen Chemicals Division
Bayport Plant
Pasadena, Texas

RFI Unit/History	Potential Appendix VIII Constituents	Dimensions/Capacity/ Construction
5. Check Tank T4889 C - active since 1979.	Naphthalene Phenol	36,000 gallons, above grade closed vessel, carbon steel on concrete slab with concrete dike.
6. H ₂ O ₂ Sewer Pits - active since 1979.	Naphthalene Phenol	144,000 gallons, below grade concrete vaults covered by a concrete slab w/entry on top.
7. Oily Sewer Pits - Active since 1979.	Naphthalene Phenol	309,000 gallons below grade concrete vaults covered by a concrete slab with entry on top.
8. Wastewater Surge Tank - active since 1984, prior to 1984 used for Acetic Acid storage.	Acrolein Allyl Alcohol Naphthalene Phenol	100,000 gallons, above grade-closed vessel.

2.4 Changes in Operational Status of RFI Units

FMC decommissioned the following units during the first quarter of 1990:

RFI Unit 3	Used Work Solution Tank
RFI Unit 4	Used Work Solution Tanks 716 A & B

RFI Unit 3, Used Work Solution Tank, was part of the Alkane Wash Unit which was permitted by the Texas Air Control Board in 1986. Prior to 1986 RFI Unit 3 was used as the Allyl Alcohol feed tank. The Alkane Wash Unit came on-line in 1986 and continued operation until mid-1987 when it was shut down. The Used Work Solution Tank is no longer in service. RFI Unit 4, Used Work Solution Tanks 716 A and B, also came on line in 1986 and is no longer in service. Prior to 1986 RFI Unit 4 was used for product glycerin storage.

Prior to decommissioning, the contents of each of these units was sampled in accordance with the procedures described in Section 4.2 of the RFI Work Plan. These samples were analyzed for Appendix VIII/40 CFR 264 Appendix IX constituents. A discussion of this sampling event is presented in Section 3.2.

3.0 RFI FIELD AND ANALYTICAL PROGRAM

As discussed in Section 1.0, Provision VIII of FMC's Hazardous Waste Permit required that an RFI be performed for the following SWMUs:

RFI Unit No.	Identity
1	Contaminated Sewer Lift Station
2	Process Sewer Lift Station
3	Used Work Solution Tank
4	Used Work Solution Tanks 716 A & B
5	Check Tank T4889C
6	H ₂ O ₂ Sewer Pits
7	Oily Sewer Pits
8	Wastewater Surge Tank T4820

The investigation requirements contained in Provision VIII segregated RFI Units 1 and 2 from RFI Units 3 through 8. Provision VIII.A.2 of the Permit required a subsurface investigation for RFI Units 1 and 2. Provision VIII.A.3 required an Appendix VIII characterization of the material contents of RFI Units 3 through 8.

To meet these requirements, the RFI Work Plan proposed a two-phased approach:

1. Phase I consisted of a soils investigation for RFI Units 1 and 2; and an Appendix VIII/40 CFR 264 Appendix IX waste characterization for RFI Units 3 through 8.
2. Phase II would be performed only if the results of the Phase I soils investigation indicated a significant release of Appendix VIII hazardous constituents from RFI Units 1 and 2. The Phase II investigation, if required, would consist of an expanded soils investigation and the possible installation of a groundwater monitoring system.

Phase I was actually initiated on February 26, 1990 with the sampling of RFI Units 3 and 4, discussed below in Section 3.2. The Phase I soils investigation for RFI Units 1 and 2 and the sampling of RFI Units 5, 6, 7, and 8 were initiated during the week of November 19, 1990.

The results of the Phase I investigation indicated that a release of Appendix VIII constituents had not occurred from RFI Units 1 and 2. Therefore, Phase II was not required.

3.1 Phase I Soil Investigation

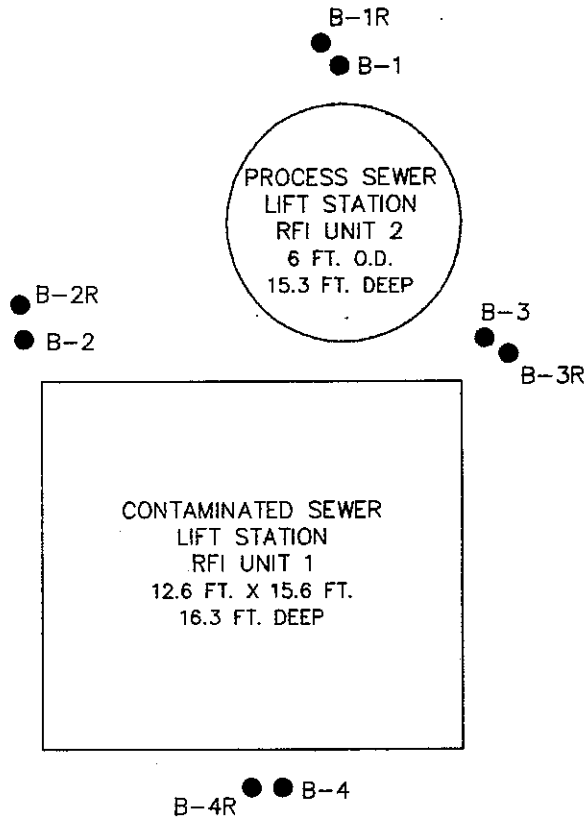
A soils investigation was performed to determine if a significant release of Appendix VIII constituents had occurred from RFI Units 1 and 2. This soils investigation consisted of collecting soil samples from six soil boring locations:

- two background locations (BKG-1 and BKG-2).
- four locations installed immediately adjacent to RFI Units 1 and 2 (B-1 through B-4).

The initial soil boring investigation was performed during the week of November 19, 1990. As discussed below in Section 4.1, laboratory holding times expired for soil samples collected for acrolein and allyl alcohol analysis. Therefore, the soil boring investigation was repeated on February 1 and 6, 1991 for the collection of soil samples for allyl alcohol and acrolein analysis. These additional soil borings (B-1R, B-2R, B-3R, B-4R, BKG-1R, and BKG-2R) were installed as close as practically possible to the original soil borings. Background soil boring locations are shown on Figure 2-2. RFI unit soil boring locations are shown on Figure 3-1.

The Phase I soil investigation, both initial and repeated, was performed under the direct supervision of ENSR geologist Shawn Eubanks. Actual drilling services were provided by Layne Environmental Services from Houston, Texas. Soil borings B-3, B-3R, B-4, B-4R, BKG-1, BKG-1R, BKG-2, and BKG-2R were drilled using a truck-mounted, hollow-stem auger drill rig in accordance with the drilling procedures set forth in Section 4.0 of the RFI Work Plan. Due to overhead access problems (e.g., pipe racks) a truck-mounted hollow-stem auger drill rig could not be used to drill soil borings B-1, B-1R, B-2, and B-2R. Therefore, a trailer-mounted continuous flight auger drill rig was used at these locations.

With the exception of soil boring B-3, each soil boring was drilled to a minimum depth of 20 feet below ground surface or to the top of the first water bearing formation, whichever was deeper. An obstruction was encountered at a depth of 18 feet at soil boring B-3; therefore, boring B-3 was terminated at that depth. The obstruction was believed to be a concrete foundation. This obstruction was not encountered at boring B-3R.



SURVEY INFORMATION
(by Shanks Land Surveyors of Texas)

SOIL BORING	NORTH	EAST	ELEVATION (FT. MSL)
B-1	2012.7	997.2	12.7
B-1R	2013.9	996.9	
B-2	1999.8	979.3	12.8
B-2R	2000.8	978.9	
B-3	2001.9	1011.4	12.9
B-3R	2001.6	1013.6	
B-4	1980.3	1000.2	12.3
B-4R	1979.8	999.1	

NOT TO SCALE

NOTES:

- ● SOIL BORING LOCATIONS ARE APPROXIMATE
- B-1, B-2, B-3 AND B-4 DRILLED ON NOVEMBER 19 AND 20, 1990.
- B-1R, B-2R, B-3R AND B-4R DRILLED ON FEBRUARY 1 AND 6, 1991.
- REFER TO SECTION 3.1 AND 4.1 FOR DISCUSSION.

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FIGURE 3-1
RFI UNIT 1 AND 2
SOIL BORING LOCATIONS
FMC CORPORATION
PASADENA, TEXAS

DRAWN BY: SJ/SJF

DATE: 12/19/89

PROJECT
NUMBER:

CHK'D BY:

REVISED: 2-21-91

2810-018-400

CE281003

Figure Frame**3-1 RFI Unit Soil Boring Locations****Pages: 1**

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At each soil boring location, soil samples were collected using either Shelby tube or split-spoon samplers. All soil samples were extruded in the field and logged by the ENSR geologist. Additionally, sample cores were scanned with an OVA flame ionization detector. The open borehole of the borings was also scanned with the OVA. Field notes from both the initial and

repeated soils investigation are presented in Appendix B. These field notes were used to prepare the soil boring lithologic logs for borings B-1, B-2, B-3, B-4, BKG-1, and BKG-2. These logs are presented in Appendix C.

During the initial soils investigation in November 1990, soil samples were retained from depth intervals of 0.5 to 1 foot, 5 feet, 10 feet, and thereafter at 5 feet intervals to total depth, for the following chemical analyses:

- pH
- Arsenic
- Cadmium
- Chromium
- Lead
- Mercury
- Allyl Alcohol
- Acrolein
- Naphthalene
- Phenol
- Endrine
- Lindane

However, due to insufficient sample volume, only allyl alcohol and acrolein analysis samples could be collected from the 1 and 5-foot depth intervals at soil borings B-3 and B-4, and the 10 feet, 15 feet and 20 feet depth intervals of soil boring BKG-2. Furthermore, a sample of the loose sand at the 20-foot depth interval at soil boring B-2 could not be retrieved. Complete sample sets were collected from all other soil boring locations and depth intervals.

The repeated soils investigation which occurred in February 1991 involved the collection of soil samples from the same depth intervals, as described above, for allyl alcohol and acrolein analysis. Additionally, soil samples were collected from the 1 and 5-foot intervals at boring B-3R and B-4R, and the 10, 15, and 20 feet depth intervals at BKG-2R for:

- | | |
|---------------|-----------|
| • Naphthalene | • Arsenic |
| • Phenol | • Cadmium |

-
- Endrine
 - Lindane
 - pH
 - Chromium
 - Lead
 - Mercury

All soil samples were labeled in the field, packed on ice in ice coolers and transported by the ENSR geologist at the end of each day of sampling to AnalytiKEM Laboratories in Houston, Texas. Upon completion, each soil boring was pressure grouted from the bottom of the boring to ground surface with a cement/bentonite slurry. Each location was staked and labeled. All soil cuttings were containerized in labeled 55-gallon steel drums and remain in the custody of FMC. All soil boring locations and ground surface elevations were surveyed by a registered surveyor.

All drilling and sampling equipment was decontaminated in accordance with the decontamination procedures set forth in Section 4.1.6 of the RFI Work Plan. A decontamination area was established near the location of RFI Units 1 and 2. The decontamination area was concrete-lined and drained to the process sewer. Drilling equipment was decontaminated with a steam cleaner/pressure washer. Sample collection equipment was decontaminated between each use by:

- scrubbing the equipment with a potable water/non-phosphate detergent mixture,
- followed by a deionized water rinse,
- followed by a light application of hexane.

3.2 Phase I Waste Characterization

In accordance with Provision VIII.A.3 of FMC's Hazardous Waste Permit, the material contents of RFI Units 3, 4, 5, 6, 7 and 8 were sampled. These samples were analyzed for Appendix VIII/40 CFR 264, Appendix IX constituents. As a result of FMC's intent to decommission RFI Units 3 and 4 during the first quarter of 1990. Units 3 and 4 were sampled on February 26, 1990; prior to agency approval of the RFI Work Plan. The RFI Work Plan, submitted in January 1990, addressed the fact that the tanks had been tentatively scheduled for decommissioning during the first quarter of 1990. FMC provided TWC a minimum of 10 days advance notice of this sampling event. A letter report describing this sampling event is presented in Appendix D.

RFI Units 5, 6, 7 and 8 were sampled during the week of November 19, 1990 for the following analyses:

- Appendix IX Pesticides and PCBs
- Appendix IX Metals

- Appendix IX Volatiles
- Appendix IX Semivolatiles
- Sulfides

The laboratory analyzed the samples collected for metals analysis from RFI Units 6 and 8 for dissolved metals rather than total metals. Therefore, RFI Units 6 and 8 were resampled for Appendix IX metals on February 1, 1991. With the exception of RFI Unit 5, these units were sampled in accordance with the sampling procedures described in Section 4.2.2 of the RFI Work Plan. The RFI Work Plan specified sampling RFI Unit 5, an aboveground tank, from its manway. However, the manway for RFI Unit 5 is located near the bottom of the tank; because this tank was determined to be partially full at the time of sampling, access through the manway was not possible. Thus, RFI Unit 5 was sampled directly from a valve located at the bottom of the tank. The sampler described the sample material as an oily water mixture.

Access to RFI Units 6 and 7, both of which are below grade tanks, was gained through manways located on top of each tank. Prior to actual sample collection an oil interface probe was used to determine the presence and thickness of any separate oily phases within each tank. At RFI 6, it was determined that a floating oil layer, approximately 2.4 inches thick was present; a bottom sludge layer, approximately 0.5 to 1 foot thick was also present. Oil and sludge layers were not observed in RFI Unit 7. Both tanks contained approximately 4 feet of fluid.

Samples collected from both RFI Units 6 and 7 represent a composite sample of three individual grab samples. At both tanks, grab samples were collected from three manways. These grab samples were then composited into one sample to represent that individual tank. At RFI Unit 6 a composite sample of the liquid and a composite sample of the sludge was collected. A representative sample of the floating oil layer in RFI Unit 6 could not be collected due to its insufficient thickness. At RFI Unit 7 a composite of the liquid was collected. A 4-inch O.D. Teflon® bailer was used to sample the liquids. A Ponar sampler was used to collect a sample of the sludge from RFI Unit 6.

4.0 LABORATORY ANALYTICAL RESULTS

Laboratory analytical reports, including test methods, quality assurance/quality control data sheets, and chain-of-custody forms are presented in Appendix F. Soil sample analytical results are summarized on Table 4-1. A summary of detected Appendix VIII/40 CFR 264 Appendix IX waste sample constituents for RFI Units 3 through 8 are summarized on Table 4-2. Laboratory analyses were performed by AnalyteKEM Laboratories in Houston, Texas and Cherry Hill, New Jersey, and Keystone Laboratories in Houston, Texas.

4.1 Expired Volatile Organic Soil Samples

The laboratory holding times for volatile organic soil samples collected from soil borings BKG-1, BKG-2, B-1, B-2, B-3, and B-4 in November 1990 expired prior to analysis. These samples were analyzed 2 days after the 14-day recommended holding time had lapsed. In a January 27, 1991 telephone conversation, Mr. Harshad Thakkar, of FMC, notified Mr. Allen Church, of TWC, of this situation and informed him of the steps that were to be taken to remedy the problem. As a result, the soil boring program was repeated on February 1 and 6, 1991 for the recollection of soil samples for acrolein and allyl alcohol analyses. The additional soil borings, BKG-1R, BKG-2R, B-1R, B-2R, B-3R, and B-4R were installed as close as practicably possible to the locations of the initial soil borings.

The results from both the November and February sampling events are presented in Appendix F. The results from the February sampling event are summarized on Table 4-1.

4.2 Appendix IX Metals Samples

The Appendix IX metals samples collected from RFI Units 6 and 8 were inadvertently analyzed for dissolved metals rather than total metals. On January 27, 1991, Mr. Harshad Thakkar, of FMC, notified Mr. Allen Church, of TWC, by telephone of this situation and informed him of the steps that were to be taken to remedy the problem. On February 1, 1991, RFI Units 6 and 8 were resampled for Appendix IX total metals. The results from both the November and February sampling events are presented in Appendix F. The Appendix IX metals results from the February sampling event are summarized on Table 4-2.

TABLE 4-1

Laboratory Analytical Report Summary - Phase I Soil Samples
RCRA Facility Investigation
FMC Corporation
Peroxygen Chemicals Division
Bayport Plant
Pasadena, Texas

Date Sampled: Unless denoted by "*", all samples collected on November 19 and 20, 1990. "*" denotes samples collected during reperformance of soil boring investigation in February 1991. Refer to Section 3.1 for discussion.						
Sample Interval (ft)	B-1	B-2	*=B-3R B-3	*=B-4R B-4	BKG-1	*=BKG-2R BKG-2
ARSENIC (mg/kg)						
1	<1.2	3.2	2.7*	1.3*	1.6	1.5
5	<1.2	2.0	3.7*	1*	2.9	10
10	<1.1	6.9	<1.4	<1.2	3.8	2.6*
15	<1.2	5.4	<1.3	<1.2	2.4	2.3*
20	<1.2	-	-	3.7	-	0.6*
29	-	-	-	-	5.5	-
CADMIUM (mg/kg)						
1	<1.2	<1.3	<2.0*	<2.0*	<1.3	<1.3
5	<1.2	<1.3	<2.0*	<2.0*	<1.3	<1.2
10	<1.1	<1.2	<1.4	<1.2	<1.3	<2.0*
15	<1.2	<1.3	<1.3	<1.3	<1.3	<2.0*
20	<1.2	-	-	<1.3	-	<2.0*
29	-	-	-	-	<1.3	-

TABLE 4-1 (Cont'd)

Laboratory Analytical Report Summary - Phase I Soil Samples
RCRA Facility Investigation
FMC Corporation
Peroxygen Chemicals Division
Bayport Plant
Pasadena, Texas

Date Sampled: Unless denoted by '*', all samples collected on November 19 and 20, 1990. '*' denotes samples collected during reperformance of soil boring investigation in February 1991. Refer to Section 3.1 for discussion.						
Sample Interval (ft)	B-1	B-2	*=B-3R B-3	*=B-4R B-4	BKG-1	*=BKG-2R BKG-2
CHROMIUM (mg/kg)						
1	6.7	26	3.5*	5.9*	31	30
5	<5.8	35	28*	3*	35	14
10	6.2	22	13	<6.2	33	6.1*
15	7.6	31	<6.3	5.9	31	4.2*
20	13	-	-	35	-	<2*
29	-	-	-	-	16	-
LEAD (mg/kg)						
1	<12	<13	<5*	<5*	<13	<13
5	<12	<13	11*	<5*	<13	<12
10	<11	<12	<14	<12	28	<5*
15	<12	34	<13	<13	<13	<5*
20	<12	-	-	<13	-	<5*
29	-	-	-	-	<13	-

TABLE 4-1 (Cont'd)

**Laboratory Analytical Report Summary - Phase I Soil Samples
RCRA Facility Investigation
FMC Corporation
Peroxygen Chemicals Division
Bayport Plant
Pasadena, Texas**

Date Sampled: Unless denoted by "**", all samples collected on November 19 and 20, 1990. "**" denotes samples collected during reperformance of soil boring investigation in February 1991. Refer to Section 3.1 for discussion.						
Sample Interval (ft)	B-1	B-2	*=B-3R B-3	*=B-4R B-4	BKG-1	*=BKG-2R BKG-2
MERCURY (mg/kg)						
1	<0.23	<0.25	<0.05*	<0.05*	<0.27	<0.26
5	<0.23	<0.27	<0.05*	<0.05*	<0.26	<0.25
10	<0.23	<0.24	<0.28	<0.25	<0.26	<0.05*
15	<0.24	<0.26	<0.25	<0.25	<0.25	<0.05*
20	<0.24	-	-	<0.25	-	<0.05*
29	-	-	-	-	<0.25	-
pH						
1	8.1	7.2	7.78*	10.67*	7.3	8.2
5	8.1	7.5	7.87*	10.32*	8.0	8.5
10	8.4	8.2	9.2	9.4	8.2	8.67*
15	8.9	8.0	8.0	8.9	8.3	8.65*
20	8.9	-	-	8.1	-	8.52*
29	-	-	-	-	8.4	-

TABLE 4-1 (Cont'd)

**Laboratory Analytical Report Summary - Phase I Soil Samples
RCRA Facility Investigation
FMC Corporation
Peroxygen Chemicals Division
Bayport Plant
Pasadena, Texas**

Date Sampled: Unless denoted by "**", all samples collected on November 19 and 20, 1990. "**" denotes samples collected during reperformance of soil boring investigation in February 1991. Refer to Section 3.1 for discussion.						
Sample Interval (ft)	B-1	B-2	*=B-3R B-3	*=B-4R B-4	BKG-1	*=BKG-2R BKG-2
NAPHTHALENE (µg/kg)						
1	<380	<420	<390*	<400*	<440	<420
5	<380	<450	<440*	<400*	<430	<410
10	<380	<400	<460	<410	<420	<400*
15	<400	<430	<420	<410	<410	<420*
20	<400	-	-	<420	-	<420*
29	-	-	-	-	<420	-
PHENOL (µg/kg)						
1	<380	<420	<390*	<400*	<440	<420
5	<380	<450	<440*	<400*	<430	<410
10	<380	<400	<460	<410	<420	<400*
15	<400	<430	<420	<410	<410	<420*
20	<400	-	-	<420	-	<420*
29	-	-	-	-	<420	-

TABLE 4-1 (Cont'd)

**Laboratory Analytical Report Summary - Phase I Soil Samples
RCRA Facility Investigation
FMC Corporation
Peroxygen Chemicals Division
Bayport Plant
Pasadena, Texas**

Date Sampled: Unless denoted by "*", all samples collected on November 19 and 20, 1990. "*" denotes samples collected during reperformance of soil boring investigation in February 1991. Refer to Section 3.1 for discussion.						
Sample Interval (ft)	B-1	B-2	*=B-3R B-3	*=B-4R B-4	BKG-1	*=BKG-2R BKG-2
ENDRINE (µg/kg)						
1	<3,800	<420	<2*	<2*	<440	<420
5	<3,800	<450	<2*	<2*	<430	<410
10	<380	<400	<460	<410	<420	<2*
15	<400	<430	<420	<410	<410	<2*
20	<400	-	-	<420	-	<2*
29	-	-	-	-	<420	-
LINDANE (µg/kg)						
1	<3,800	<420	<2*	<2*	<440	<420
5	<3,800	<450	<2*	<2*	<430	<410
10	<380	<400	<460	<410	<420	<2*
15	<400	<430	<420	<410	<410	<2*
20	<400	-	-	<420	-	<2*
29	-	-	-	-	<420	-

TABLE 4-1 (Cont'd)

**Laboratory Analytical Report Summary - Phase I Soil Samples
RCRA Facility Investigation
FMC Corporation
Peroxygen Chemicals Division
Bayport Plant
Pasadena, Texas**

Date Sampled: February 16, 1990. Refer to Section 3.1 and 4.1 for discussion.						
Sample Interval (ft)	B-1R	B-2R	B-3R	B-4R	BKG-1R	BKG-2R
ALLYL ALCOHOL ($\mu\text{g}/\text{kg}$)						
1	<590	<540	<600	<600	<680	<670
5	<660	<690	<670	<610	<650	<610
10	<610	<610	<640	<660	<560	<610
15	<630	<600	<570	<600	<610	<630
20	<640	<620	<650	<650	<660	<630
ACROLEIN ($\mu\text{g}/\text{kg}$)						
1	<59	<54	<60	<60	<68	<67
5	<66	<69	<67	<61	<65	<61
10	<61	<61	<64	<66	<56	<61
15	<63	<60	<57	<60	<61	<63
20	<64	<62	<65	<65	<66	<63

TABLE 4-2

**Laboratory Analytical Report Summary
Constituents Detected in RFI Units 3 Through 8
RCRA Facility Investigation
FMC Bayport Plant, Pasadena, Texas**

RFI Unit 3 (Solids)		RFI Unit 4 Tank MF716-A (Solids)		RFI Unit 4 Tank MF716-B (Solids)	
Constituent	Concentration	Constituent	Concentration	Constituent	Concentration
Aluminum	410 ppm	Aluminum	30,000 ppm	Aluminum	28,000 ppm
Calcium	450 ppm	Arsenic	2.6 ppm	Barium	87 ppm
Iron	24 ppm	Barium	120 ppm	Calcium	33,000 ppm
Potassium	6.4 ppm	Calcium	34,000 ppm	Cadmium	1.5 ppm
Magnesium	58 ppm	Cadmium	1.8 ppm	Cobalt	10 ppm
Sodium	70 ppm	Cobalt	11 ppm	Chromium	40 ppm
Zinc	8.2 ppm	Chromium	34 ppm	Copper	43 ppm
Methylene Chloride**	310 ppm	Copper	31 ppm	Iron	2,700 ppm
Acetone	330 ppm*	Iron	3,300 ppm	Mercury	0.4 ppm
Naphthalene	130 ppm	Potassium	380 ppm	Potassium	250 ppm
2-Methyl-naphthalene	240 ppm	Magnesium	1,800 ppm	Magnesium	3,700 ppm
2-Chloro-naphthalene	23 ppm	Manganese	43 ppm	Lead	25 ppm
TCDDs (total)	1.6 ppb	Sodium	1,900 ppm	Manganese	58 ppm
PeCDDs (total)	2.5 ppb	Nickel	11 ppm	Sodium	3,500 ppm
HxCDD's (total)	5.2 ppb	Lead	26 ppm	Nickel	19 ppm
Sulfide	66 ppm	Antimony	2.3 ppm	Antimony	1.0 ppm
		Tin	500 ppm	Tin	410 ppm
		Vanadium	20 ppm	Vanadium	24 ppm
		Zinc	560	Zinc	520 ppm
		Methylene Chloride	8 ppm	Methylene Chloride	3.1 ppm
		Acetone	11 ppm*	Acetone	5 ppm*
		Naphthalene	66 ppm	Naphthalene	180 ppm
		2-Methyl-naphthalene	170 ppm	2-Methyl-naphthalene	170 ppm
		Cyanide	0.9 ppm	Cyanide	1.9 ppm

* Detected in laboratory QA/QC blank.

** Although detected in the waste sample, methylene chloride is not, nor has it ever been, used or produced in any process at the FMC Corporation Bayport Plant.

Note: RFI Units 3 and 4 sampled on February 26, 1990.

TABLE 4-2 (Cont'd)

**Laboratory Analytical Report Summary
Constituents Detected in RFI Units 3 Through 8
RCRA Facility Investigation
FMC Bayport Plant, Pasadena, Texas**

RFI Unit 5 (Liquid)		RFI Unit 6 (Liquid)	
Constituent	Concentration	Constituent	Concentration
Arsenic	0.0065 ppm	Arsenic	0.006 ppm
Barium	0.036 ppm	Barium	0.1 ppm
Chromium	0.0145 ppm	Chromium	0.02 ppm
Copper	0.17 ppm	Copper	0.03 ppm
Lead	0.0055 ppm	Tin	11 ppm
Zinc	0.2 ppm	Zinc	0.4 ppm
Selenium	0.0046 ppm	2-Methyl-naphthalene	150 ppb
2-Methyl-naphthalene	200 ppm	Naphthalene	3.1 ppm
Naphthalene	3,900 ppm	Sulfides	3.5 ppm
Total Xylenes	4.2 ppm		
Sulfides	28.0 ppm		

RFI Unit 7 (Liquid)		RFI Unit 7 (Sludge)		RFI Unit 8 (Liquid)	
Constituent	Concentration	Constituent	Concentration	Constituent	Concentration
Barium	2 ppm	Beryllium	0.75 ppm	Barium	0.02 ppm
Beryllium	0.008 ppm	Copper	26 ppm	Mercury	0.06 ppm
Cadmium	0.011 ppm	Nickel	9.9 ppm	Tin	0.1 ppm
Chromium	1.15 ppm	Silver	2.6 ppm	Zinc	0.1 ppm
Copper	0.9 ppm	Tin	1,300 ppm	Acetone	37 ppm
Nickel	0.26 ppm	Zinc	638 ppm	Chloroform	1.3 ppm
Thallium	0.9 ppm	Acetone	370 ppm	Naphthalene	240 ppb
Tin	1.1 ppm	2-Methylnaphthalene	460 ppm	Sulfides	2.9 ppm
Zinc	13 ppm	Naphthalene	930 ppm	Toluene	2.9 ppm
2-Methylnaphthalene	190 ppm	Bis(2-ethylhexyl)phthalate	120 ppm		
Naphthalene	2,900 ppm	Xylenes (Total)	89 ppm		
Sulfides	27 ppm	Sulfides	2,258 ppm		

RFI Units 5, 6, 7, and 8 sampled on November 19 and 20, 1990.

RFI Units 6 and 8 resampled on February 1, 1991 for Appendix IX metals.

Refer to Section 4.2 for discussion.

5.0 EVALUATION OF ANALYTICAL DATA

5.1 Statistical Evaluation of RFI Units 1 and 2 Soil Sample Data

Section 6.1 of the RFI Work Plan specified that the determination of whether a significant release of Appendix VIII constituents had occurred from RFI Units 1 and 2 would be made by statistically comparing background soil data to waste management unit soil data.

Discussed below are the methods used to evaluate the analytical data, the criteria used for selecting the statistical methods, and the results of the evaluation. Copies of worksheets are presented in Appendix F.

Statistical evaluations were performed only for those parameters detected in the waste management unit soil borings. The following constituents were not detected in any soil samples:

- cadmium,
- mercury,
- naphthalene,
- phenol,
- endrine,
- lindane,
- allyl alcohol, or
- acrolein.

It is, therefore, concluded that a release of these constituents has not occurred at soil boring locations B-1 through B-4.

Statistical evaluations were performed for:

- arsenic
- chromium
- lead
- pH

5.1.1 Statistical Test Method Selection

As specified in the guidance document, Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, EPA, February 1989 (hereafter referred to as the Guidance Document), the selection of a particular test method is dependent on the proportion of nondetects within each data set. For our purposes, a data set corresponds to all data collected for a particular parameter. Thus, all arsenic data would constitute one data set.

Listed below are the proportions of nondetects for each parameter under evaluation.

<u>Parameter</u>	<u>Proportion of Non-detects (%)</u>
Arsenic	32
Chromium	14
Lead	89
pH	N/A

In accordance with the Guidance Document, those data sets which have a proportion of non-detects greater than or equal to 50% should be evaluated using a test of proportion analysis. ANOVA is recommended where the proportion of non-detects is less than 50%. Therefore, the lead data will be evaluated using a test of proportion analysis. Arsenic, chromium, and pH data were evaluated using ANOVA procedures.

There are two types of ANOVA methods: parametric and non-parametric. The choice between the use of parametric and non-parametric ANOVA methods is dependent on the distribution of the data within each data set, and the proportion of non-detects within each data set. A non-parametric ANOVA method is recommended if the proportion of non-detects is greater than or equal to 15% and less than 50%.

A parametric ANOVA is recommended if the proportion of non-detects is less than 15% and the data is normally distributed, or the data is not normally distributed but can be normalized by taking the natural log of each datum.

In keeping with the statistical procedures described in the Guidance Document, a coefficient-of-variation (CV) test was used to determine whether the data sets for chromium and pH were

normally distributed. If the CV exceeded 1.00, then the data is not normally distributed. The CV test procedure was performed as follows:

1. Calculate sample mean \bar{X} of n observations, x_i , $i=1, \dots, n$.

$$\bar{X} = \left[\sum_{i=1}^n x_i \right] / n$$

2. Calculate sample standard deviation S .

$$S = \left[\sum_{i=1}^n (x_i - \bar{X})^2 / (n-1) \right]^{1/2}$$

3. Calculate coefficient of variation.

$$CV = S / \bar{X}$$

Applying this procedure to the chromium and pH data:

<u>Parameter</u>	<u>Sample Mean</u> \bar{X}	<u>Sample Standard</u> <u>Deviation, S</u>	<u>CV</u>
Chromium	16.15	12.61	0.78
pH	8.44	0.78	0.09

Therefore, it is concluded that the chromium and pH data are normally distributed.

Based on the above results, the following statistical test methods will be used.

Statistical Test Methods

<u>Parameter</u>	<u>Test Method</u>
Arsenic	Non-Parametric ANOVA
Chromium	Parametric ANOVA
Lead	Test of Proportions
pH	Parametric ANOVA

5.1.2 Evaluation of Arsenic Data

As determined above, the arsenic data will be evaluated using a non-parametric ANOVA method; specifically the Kruskal-Wallis test. Non-detects were replaced with 1/2 the detection limit for purposes of the evaluation. The procedure used to evaluate the arsenic data was as follows:

- Step 1. Average background concentrations for each depth interval.
- Step 2. Rank all concentrations from least to greatest. Let R_{ij} denote the rank of the j^{th} concentration in the i^{th} group.
- Step 3. Add the ranks of the concentrations from each boring location. Call the sum of the ranks for the i^{th} group R_i . Calculate the average rank for each group, $\bar{R}_i = R_i/N_i$.
- Step 4. Compute the Kruskal-Wallis statistic, H and the Kruskal-Wallis statistic corrected for ties, H' .

$$H = \left[\frac{12}{N(N+1)} \sum_{i=1}^k \frac{R_i^2}{N_i} \right] - 3(N+1)$$

$$H' = \frac{H}{1 - \left[\frac{g}{\sum_{i=1}^g T_i / (N^3 - N)} \right]}$$

- Step 5. Compare the calculated value H , or if necessary H' , to the tabulated chi-squared value with $(K-1)$ degrees of freedom, where k is the number of soil boring locations. Reject the null hypothesis if the computed value exceeds the tabulated critical value.

- Step 6. If the null hypothesis is rejected, compute the critical difference for well comparisons to the mean concentrations from background soil boring locations.

$$C_I = Z_{(\alpha/(k-1))} \left[\frac{N(N+1)}{12} \right]^{1/2} \left[\frac{1}{n_1} + \frac{1}{n_I} \right]^{1/2}$$

- Step 7. Form the difference of the average ranks for each soil boring location to the mean concentrations from the background locations and compare with the critical values found in Step 6 to determine which boring locations give evidence of contamination.

Applying this procedure to the arsenic data yields the following:

- Step 1. Calculate mean background arsenic concentration BG.

Depth (ft)	BKG-1	BKG-2	$\overline{\text{BG}}$
1	1.6	1.5	1.55
5	2.9	10	6.45
10	3.8	2.6	3.2
15	2.4	2.3	2.35
20	-	0.6	0.6
29	5.5	-	5.5

- Steps 2&3 Rank and average ranks.

See Table 5-1.

TABLE 5-1

Ranking Data for Non-Parametric ANOVA -
Arsenic Concentration (mg/kg)
RFI Units 1 and 2
RCRA Facility Investigation
FMC Peroxygen Chemicals Division
Bayport Plant

Depth (ft)	Background Mean	Soil Boring Location			
	BG	B-1	B-2	B-3	B-4
1	1.55(13)	0.6(5)	3.2(17.5)	2.7(16)	1.3(12)
5	6.45(22)	0.6(5)	2.0(14)	3.7(19.5)	1(11)
10	3.2(17.5)	0.55(1)	6.9(23)	0.7(10)	0.6(5)
15	2.35(15)	0.6(5)	5.4(21)	0.65(9)	0.6(5)
20	0.6(5)	0.6(5)	-	-	3.7(19.5)
	$N_1 = 5$	$N_2 = 5$	$N_3 = 4$	$N_4 = 4$	$N_5 = 5$
Sum of Ranks	72.5	21	75.5	54.5	52.5
Average Rank	14.5	4.2	18.88	13.63	10.50
K = 5 N = 23					

Step 4. Calculate H and H'.

$$H = \frac{12}{23(23+1)} (72.5^2/5 + \dots + 52.5^2/5) - 3(23+1)$$

$$H = 11.73$$

Adjustment for ties:

There are three groups of ties in the arsenic data on Table 4-1.

$$T_1 = (7^3 - 7) = 336 \text{ for the 7 observations of 0.6.}$$

$$T_2 = (2^3 - 2) = 6 \text{ for the 2 observations of 3.2}$$

$$T_3 = (2^3 - 2) = 6 \text{ for the 2 observation of 3.7}$$

$$\text{Thus } T_i = 348$$

$$H' = \frac{11.73}{1 - [(348)/(23^3 - 23)]}$$

$$H' = 12.08$$

From Table 1, Appendix B of the Guidance Document, the critical chi-squared value with 4 degrees of freedom at the 5% level of significance is 9.488. Since H' is greater than 9.488 the null hypothesis is rejected and individual comparisons between background soil boring concentrations and waste management unit soil boring concentrations are required.

Critical values for B-1, B-2, B-3, and B-4:

$$(\alpha/k-1) = 0.05/4 = 0.013$$

$$Z(\alpha/k-1) = 2.33 \text{ Table 4, Appendix B of the Guidance Document}$$

$$C_{B-1} = 9.99$$

$$C_{B-2} = 10.60$$

$$C_{B-3} = 10.60$$

$$C_{B-4} = 9.99$$

Differences between the average rank of each waste management unit soil boring and average rank of the background arsenic data:

	<u>Differences</u>	<u>Critical Values</u>
D _{B-1}	4.2 - 14.5 = -10.3	9.99
D _{B-2}	18.88 - 14.5 = 4.38	10.60
D _{B-3}	13.63 - 14.5 = -0.87	10.60
D _{B-4}	10.50 - 14.5 = -4.00	9.99

These results indicate that background arsenic concentrations are statistically significantly higher than the arsenic concentration from soil samples from soil boring B-1. Thus, there is no evidence of a significant release of arsenic at soil boring locations B-1, B-2, B-3, and B-4.

5.1.3 Evaluation of Chromium Data

As determined above, the proportion of non-detects with the chromium data set is less than 15% and the chromium data is normally distributed. Therefore, the chromium data will be statistically evaluated using the parametric ANOVA method. Non-detects were evaluated at 1/2 detection limit.

The procedure that was used to evaluate the chromium data using the parametric ANOVA test was as follows:

Step 1. Arrange all data in a data table.

Step 2. Compute total concentrations and mean concentrations as follows:

$$X_i = \sum_{j=1}^{n_i} X_{ij} \text{ total of all } n_i \text{ observations at soil boring } i$$

$$\bar{X}_i = \frac{1}{n_i} X_i \text{ average of all } n_i \text{ observations at soil boring } i$$

$$X_g = \sum_{i=1}^P \sum_{j=1}^{n_i} X_{ij} \text{ grand total of all } n_i \text{ observations,}$$

$$\bar{X}_g = \frac{1}{N} X_g \text{ grand mean of all observations}$$

Step 3. Compute the sum of squares of differences between soil boring means and the grand mean:

$$SS_{S.B.} = \sum_{i=1}^P n_i (\bar{X}_i - \bar{X}_g)^2$$

Step 4. Compute the corrected total sum of squares

$$SS_{total} = \sum_{i=1}^P \sum_{j=1}^{n_i} (X_{ij} - \bar{X}_g)^2$$

Step 5. Compute the sum of squares of differences of observations within soil borings from the soil boring means. This is the sum of squares due to error and is obtained by subtraction:

$$SS_{error} = SS_{total} - SS_{S.B.}$$

- Step 6. Set up an ANOVA table and calculate Mean Square between soil borings (MS borings), Mean Square of error between soil borings (MS error), and the F-statistic:

$$MS \text{ borings} = SS \text{ borings} / (p-1)$$

$$MS \text{ errors} = SS \text{ error} / N-P$$

$$F = MS \text{ borings} / MS \text{ error}$$

- Step 7. Test hypothesis of equal soil boring means by comparing the calculated F-statistic to a tabulated F-statistic (Table 2, Appendix B of the Guidance Document) at the 5% significance level. If the calculated F-statistic exceeds the tabulated value, reject the hypothesis of equal means.

- Step 8. If the hypothesis of equal soil boring means is rejected, determine whether the significant F-statistic is due to differences between background and Waste Management Unit soil borings by use of Bonferroni t-statistics.

Applying this procedure to the chromium data yields the following:

- Step 1. Arrange the Chromium data in a data table.

See Table 5-2.

- Step 2. Compute Soil boring totals and means.

See Table 5-2.

- Step 3. Compute to between soil boring sum of squares

$$SS_{S.B.} = \left(\frac{130^2}{5} + \dots + \frac{52.9^2}{5} \right) - 1/27 (436.20^2)$$

$$SS_{S.B.} = 2,429.68 @ 5 \text{ degrees of freedom}$$

TABLE 5-2

Parametric ANOVA Data - Chromium Concentrations (mg/kg)
RFI Units 1 and 2
RCRA Facility Investigation
FMC Peroxygen Chemicals Division
Bayport Plant

Soil Boring Location	Depth (ft)					Total (Σ)	Mean (\bar{X})
	1	5	10	15	20		
BKG-1	31	35	33	31	-	130	32.5
BKG-2	30	14	6.1	4.2	1	55.3	11.06
B-1	6.7	2.9	6.2	7.6	13	36.4	7.28
B-2	26	35	22	31	-	114	28.5
B-3	3.5	28	13	3.1	-	47.6	11.9
B-4	5.9	3	3.1	5.9	35	52.9	10.58
$\Sigma X_G = 436.20$ $\Sigma X_G = 16.156$							

Step 4. Compute the corrected total sum of squares

$$S.S._{total} = (31^2 + \dots + 35^2) - 1/27 (436.20^2)$$

$$S.S._{total} = 4,293.39 \text{ @ } 26 \text{ degrees of freedom}$$

Step 5. Calculate the error sum of squares

$$SS_{error} = 4,293.39 - 2,429.68 = 1,863.71 \text{ @ } 21 \text{ degrees of freedom}$$

Step 6. Set up ANOVA table

See Table 5-3

The calculated F-statistic is 5.48. The tabulated F value with 5 and 21 degrees of freedom at the 0.5 level of significance is 2.68, from Table 2 of Appendix B of the Guidance Document. Since the calculated F value is greater than the tabulated value, the hypothesis of equal means is rejected. Therefore, the next step is to determine source of the significant differences.

Step 7. Computation of Bonferroni t-statistics

There are four SWMU boring locations, therefore M=4 comparisons will be made.

$N_{BKG} = 9$ = total number of background samples from BKG-1 and BKG-2.

$$\bar{X}_{BKG} = 20.589$$

Compute difference between the average concentration of the background borings to the average concentration of each SWMU boring.

$$\bar{X}_{B-1} - \bar{X}_{BKG} = 7.28 - 20.589 = -13.31$$

$$\bar{X}_{B-2} - \bar{X}_{BKG} = 28.5 - 20.589 = 7.91$$

$$\bar{X}_{B-3} - \bar{X}_{BKG} = 11.9 - 20.589 = -8.689$$

TABLE 5-3

**Parametric ANOVA Table - Chromium Data
RFI Units 1 and 2
RCRA Facility Investigation
FMC Peroxygen Chemicals Division
Bayport Plant**

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Soil Borings	2,429.68	5	485.94	5.48
Error Within	1,863.71	21	88.75	
Total	4,293.39	26		

$$\bar{X}_{B-4} - \bar{X}_{BKG} = 10.58 - 20.589 = -10.01$$

Compute standard error, SE

$$SE_1 = [MS_{error} (1/N_{BKG} + 1/N_i)]^{1/2}$$

$$SE_4 = [88.75 (1/9 + 1/4)]^{1/2} = 5.66$$

$$SE_5 = [88.75 (1/9 + 1/5)]^{1/2} = 5.25$$

From Table 3, Appendix B of Guidance Document, t with (27-6) = 21 degrees of freedom at M=4 and $\alpha = 0.05$; $t \approx 2.39$.

$$D_4 = T \times SE_4 = (2.39)(5.66) = 13.5$$

$$D_5 = T \times SE_5 = (2.39)5.25 = 12.55$$

<u>Boring</u>	<u>Critical Value</u>	<u>Difference</u>
B-1	12.55	-13.31
B-2	13.5	7.91
B-3	13.5	-8.689
B-4	12.55	-10.01

The F test was significant at the 5% level. The Bonferroni test was used to determine the source of the significant difference. Of the four differences, only $\bar{X}_{B-1} - \bar{X}_{BKG} = -13.31$ exceeded the critical value of 12.55. However, because this difference is negative, it indicates that the background concentration is statistically greater than the concentration from B-1. Therefore, there is no evidence of a release of chromium at boring locations B-1, B-2, B-3, and B-4.

5.1.4 Evaluation of Lead Data

The proportion of non-detects within the lead data set is greater than 50%. Therefore, the lead data will be evaluated using a test of proportion analysis.

The test of proportions procedure is as follows:

- Step 1. Determine x , the number of background samples in which the compound was detected. Let n be the total number of background samples. Compute the proportion of detects.

$$P_u = x/n$$

- Step 2. Determine y , the number of Waste Management Unit samples in which the compound was detected. Let M be the total number of Waste Management Unit soil samples analyzed.

- Step 3. Compute the standard error of the difference in proportions and form the statistic.

$$Z = (P_u - P_d)/S_D$$

- Step 4. Compare the absolute value of z to the standard normal distribution, 1.96. If the absolute value of Z exceeds 1.96, this provides evidence, at the 5% level of significance, of contamination.

Applying this procedure to the lead data yields the following results:

- Step 1. Calculate the proportion of detects within the background data set.

$$X = 1, n = 10$$

$$P_u = 1/10 = 0.10$$

- Step 2. Calculate the proportion of detects within the waste management unit data set

$$Y = 2, m = 18$$

$$P_d = 2/18 = 0.11$$

Step 3. Calculate the standard of error and the Z statistic

$$S_D = [(1+2)/(10+18)][1-(1+2)/(10+18)][1/10+1/18]^{1/2}$$

$$S_D = 0.122$$

$$Z = \frac{0.10 - 0.11}{0.122}$$

$$Z = -0.08$$

Since the absolute value of the calculated Z statistic is less than 1.96, there is no evidence of lead contamination at soil borings B-1, B-2, B-3, and B-4.

5.1.5 Evaluation of pH Data

As determined above, the pH data is normally distributed. Therefore, the pH data will be evaluated using the parametric ANOVA method.

The procedure that was used to evaluate the pH data is the same as that described above for the evaluation of chromium data. Applying this procedure to the pH data yields the following:

Step 1. Arrange the pH data in a data table

See Table 5-4.

Step 2. Compute soil boring totals and means

See Table 5-4.

Step 3. Compute the between soil boring sum of squares

$$SS_{S.B.} = \left(\frac{31.8^2}{5} + \dots + \frac{47.39^2}{5} \right) - 1/27 (227.84^2)$$

$$SS_{S.B.} = 8.62 \text{ @ } 5 \text{ degrees of freedom}$$

TABLE 5-4

Parametric ANOVA Data - pH Concentrations
RFI Units 1 and 2
RCRA Facility Investigation
FMC Peroxygen Chemicals Division
Bayport Plant

Soil Boring Location	1	5	10	15	20	Total (X_i)	Mean (\bar{X}_i)
BKG-1	7.3	8.0	8.2	8.3	-	31.8	7.95
BKG-2	8.2	8.5	8.67	8.65	8.52	42.5	8.51
B-1	8.1	8.1	8.4	8.9	8.9	42.4	8.48
B-2	7.2	7.5	8.2	8.0	-	30.9	7.72
B-3	7.78	7.87	9.2	8.0	-	32.85	8.21
B-4	10.67	10.32	9.4	8.9	8.1	47.39	9.47
$X_G = 227.84$ $\bar{X}_G = 8.44$							

Step 4. Compute the corrected total sum of squares

$$SS_{total} = (7.3^2 + \dots + 8.1^2) - 1/27 (227.84^2)$$

$$SS_{total} = 17.03 \text{ @ } 26 \text{ degrees of freedom}$$

Step 5. Calculate the error sum of squares

$$SS_{error} = 17.03 - (8.62) = 8.41 \text{ @ } 21 \text{ degrees of freedom}$$

Step 6. Set up ANOVA table

See Table 5-5.

The calculated F statistic is 4.3. The tabulated F value with 5 and 21 degrees of freedom at the 0.5 level of significance is 2.68, from Table 2 of Appendix B of the Guidance Document. Since the calculated F value is greater than the tabulated value, the hypothesis of equal means is rejected. Therefore, the next step is to determine the source of the significant difference.

Step 7. Computation of Bonferroni t-statistics

There are four SWMU boring locations, therefore, M=4 comparisons will be made.

$N_{BKG} = 9$ = total number of background samples from BKG-1 and BKG-2.

$$\bar{X}_{BKG} = 8.26$$

TABLE 5-5

**Parametric ANOVA Table - pH Data
RFI Units 1 and 2
RCRA Facility Investigation
Peroxygen Chemicals Division
Bayport Plant**

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Soil Borings	8.62	5	1.72	4.3
Error Within	8.41	21	0.4	
Total	17.03	26		

Compute difference between the average concentration of the background borings to the average concentration of each SWMU boring.

$$\bar{X}_{B-1} - \bar{X}_{BKG} = 8.48 - 8.26 = 0.22$$

$$\bar{X}_{B-2} - \bar{X}_{BKG} = 7.72 - 8.26 = -0.54$$

$$\bar{X}_{B-3} - \bar{X}_{BKG} = 8.21 - 8.26 = -0.05$$

$$\bar{X}_{B-4} - \bar{X}_{BKG} = 9.47 - 8.26 = 1.21$$

Compute standard error, SE

$$SE_i = [MS_{error}(1/N_{BKG} - 1/N_i)]^{1/2}$$

$$SE_4 = [(0.4)(1/9 + 1/4)]^{1/2} = 0.38$$

$$SE_5 = [(0.4)(1/9 + 1/5)]^{1/2} = 0.35$$

$$T_{tabulated} \approx 2.39$$

$$D_4 = T \times SE_4 = (2.39)(.38) = 0.91$$

$$D_5 = T \times SE_5 = (2.39)(.35) = 0.84$$

<u>Boring</u>	<u>Critical Value</u>	<u>Difference</u>
B-1	0.84	0.22
B-2	0.91	-0.54
B-3	0.91	-0.05
B-4	0.84	1.21

The F test was significant at the 5% level. The Bonferroni test was used to determine the source of the significant difference. Of the four differences, $\bar{X}_{B-4} - \bar{X}_{BKG} = 1.21$ exceeded the critical value of 0.84. Therefore, this result indicates that the pH values at B-4 are statistically higher than the pH values found in the background borings. Specifically, it appears that the pH of the soil at the 1 and 5 foot intervals at boring B-4 are the source of the significant difference.

5.2 Summary of RFI Units 3 Through 8 Waste Analysis Data

In accordance with the evaluation procedures of Section 6.2 of the RFI Work Plan, it has been determined that RFI Units 3, 4, 5, 6, 7, and 8 each contain Appendix VIII/40 CFR 264 Appendix IX constituents. These constituents are summarized for each unit on Table 4-2.

6.0 SUMMARY OF RFI FINDINGS

6.1 RFI Units 1 and 2

In accordance with Provision VIII.A.2 of FMC's Part B Permit, a subsurface soils investigation was performed at RFI Units 1 and 2 (the Contaminated Sewer Lift Station and Process Sewer Lift Station) for the purpose of determining whether Appendix VIII constituents had been released into the subsurface. The subsurface investigation consisted of collecting soil samples from soil borings located adjacent to RFI Units 1 and 2 and at locations representing background conditions. Soil samples were logged in the field for geologic description and field screening observations. Certain soil samples were retained for chemical analysis.

6.1.1 Geologic Conditions

Figure 6-1 depicts a cross-section of RFI Units 1 and 2. The near surface geology immediately surrounding RFI Units 1 and 2 can be generally described as consisting of approximately 7 to 10 feet of fill material. This fill material was described as consisting of a clayey silt to clayey sand with gravel and shell fragments. Underlying the fill material a water-bearing clayey sand and sandy silt material was observed at soil borings B-1, B-3, and B-4 in thickness ranging from 8 to 11 feet. At boring B-2, a 5-foot silty clay layer was described immediately underlying the fill material. A clay to silty clay material was encountered at depths ranging from 11 to 18 feet below ground surface. Soil boring lithologic logs are presented in Appendix C.

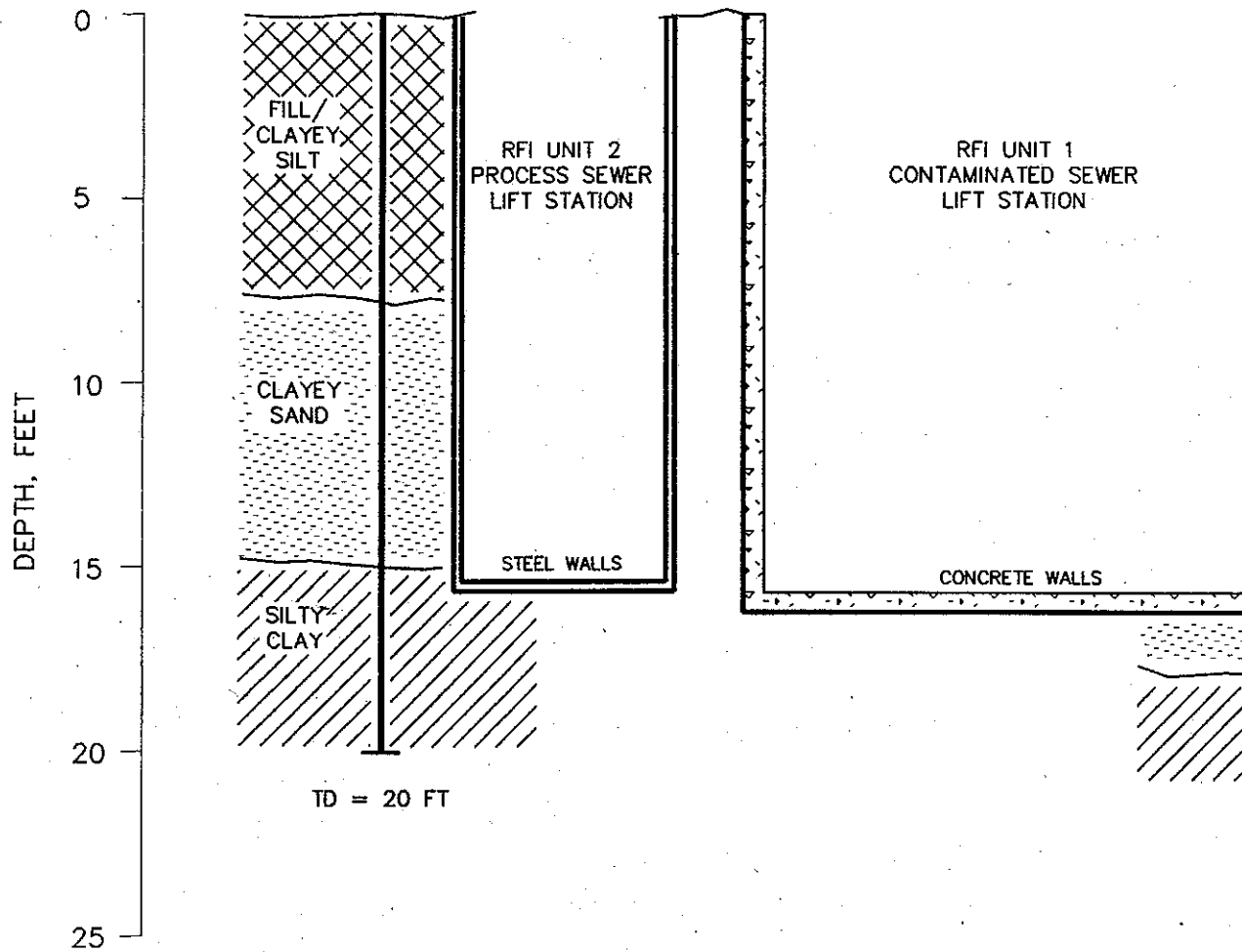
6.1.2 Appendix VIII Release Determination

Soil samples collected from each of the soil borings were analyzed for pH and Appendix VIII constituents which were or may have been managed in RFI Units 1 and 2. These analyses consisted of determining the concentrations of the following Appendix VIII constituents:

- Arsenic
- Cadmium
- Chromium
- Lead
- Mercury
- Napthalene
- Phenol
- Endrine
- Lindane
- Allyl Alcohol
- Acrolein

A

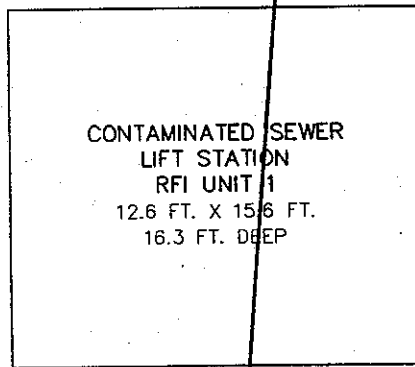
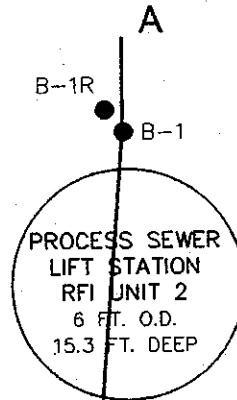
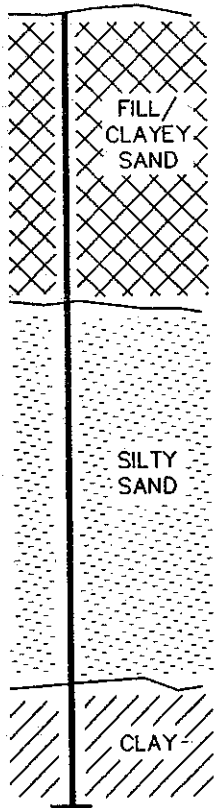
B-1



NOTE: CROSS-SECTION SCALE ; 1" = 5'

A'

B-4



NOT TO SCALE



B-4R B-4
A'

ENSRTM

ENSR CONSULTING & ENGINEERING

FIGURE 6-1
CROSS SECTION A-A'
FMC CORPORATION
PASADENA, TEXAS

DRAWN: SJF	DATE: 2-27-91	PROJECT NUMBER:
APP'D:	REVISED:	2810-018

The results of these analyses were compared to background concentrations to determine whether a release had occurred. The results of these evaluations indicate that a release of Appendix VIII constituents has not occurred at any of the Waste Management Unit soil boring locations. The result of the pH evaluation indicates that the pH of the soils in boring B-4 are statistically higher than the pH of the soils in the background borings. The source of the statistical difference at boring B-4 is the pH values of 10.67 and 10.32 from the 1 and 5 foot depth intervals. These samples were collected from boring B-4R which is located only 1 to 2 feet from B-4. As discussed above, boring B-4R was installed after boring B-4. It is very possible that the pH values from 1 and 5 foot depth intervals at boring B-4R were influenced by residual grout from boring B-4.

6.2 RFI Units 3 Through 8

In accordance with Provision VIII.A.3 of FMC's Part B Permit, the material contents of RFI Units 3 through 8 were sampled and analyzed for Appendix VIII/40 CFR 264 Appendix IX constituents. These results indicate that each of the units contain various Appendix VIII/40 CFR 264 Appendix IX constituents. A summary of these results is presented in Section 4.0.